# **Heat Pipe Receiver Development**

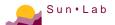




# **Heat Pipe Receiver Development**





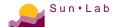


### **Heat Pipe Receiver Development Drivers**

- Performance enhancement
  - 20% throughput performance Demonstrated
  - Increased cycle temperatures
  - Improved cylinder power balance
- Life enhancement
  - Reduced stresses
  - Flux leveling
- Design flexibility
  - Mate unconventional engine configurations to solar dish
  - Independent Solar Receiver and Engine design
- Cost Reduction
  - System cost (mirror area reduced)
  - O&M
- Thermal mass
  - Improves engine controls
  - Critical for non-grid systems

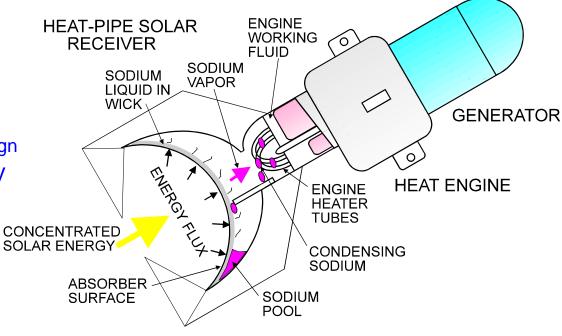






#### **Heat Pipe Receiver Development**

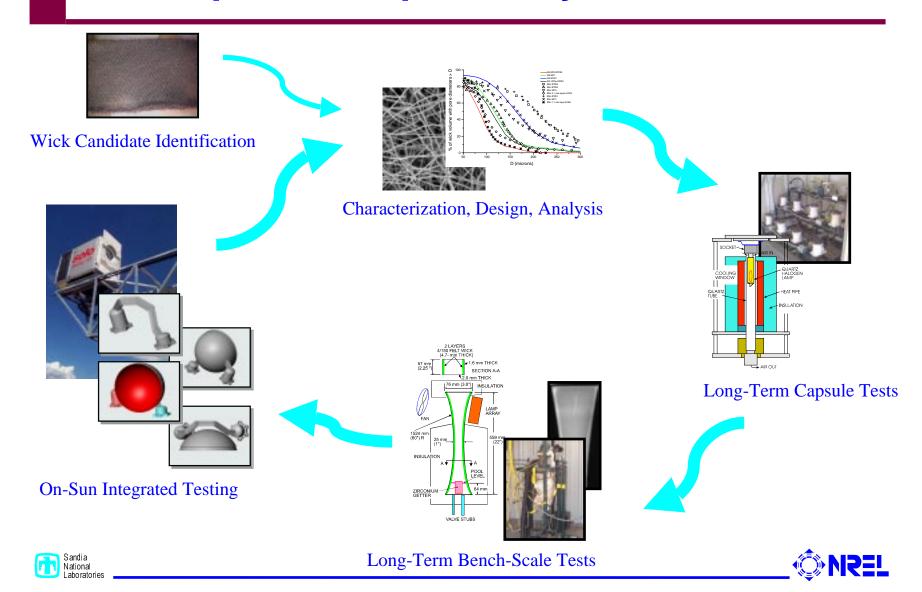
- Objective: Develop a cost-effective reliable reflux receiver that significantly enhances 10- and 25-kW Dish Stirling systems
- Development Areas
  - Wick
    - Throughput performance
    - Corrosion in Sodium
    - Life
  - Engine interface
    - Proper reflux return to wick
    - Thermal expansion
    - Non-compromising engine design
  - Sodium handling and safety



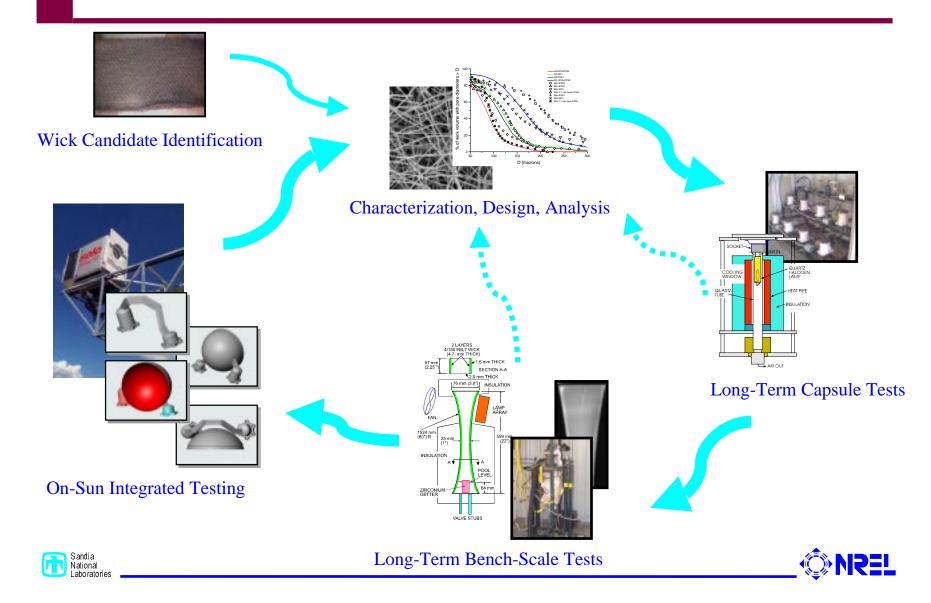


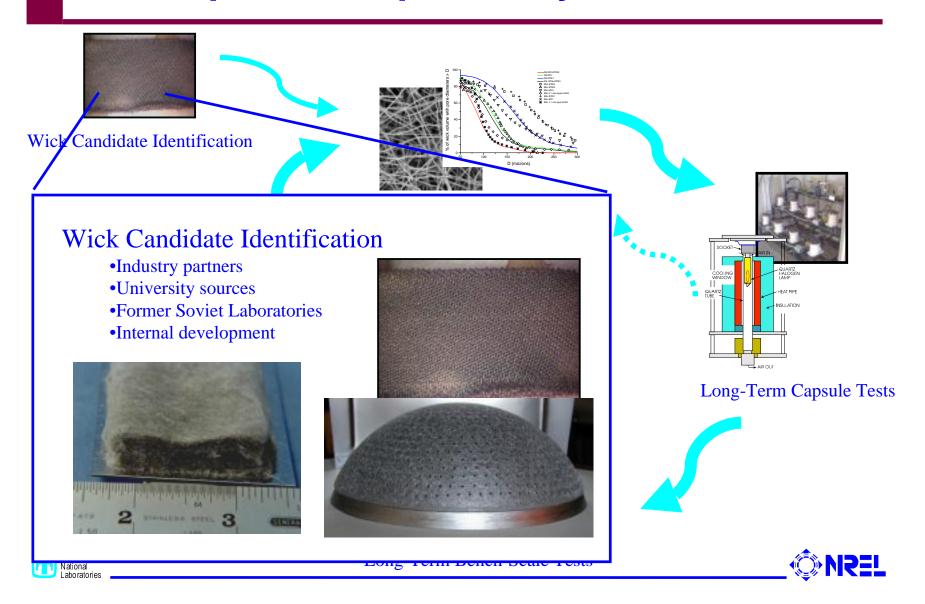


#### Sun•Lab

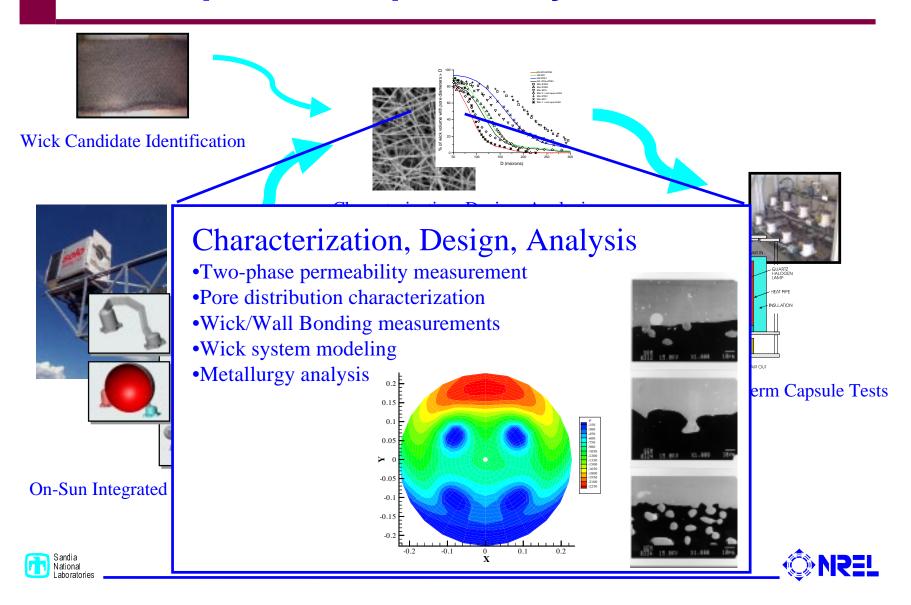


#### Sun•Lab

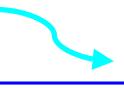


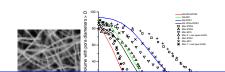








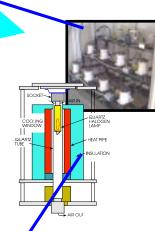




#### **Long-Term Capsule Tests**

- •Unattended testing
- •Materials, Methods, and Combinations
- •Low-cost, simple devices
- •Refluxing sodium exposure at temperature

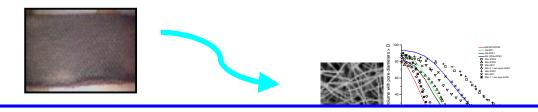




Long-Term Capsule Tests







#### Long-Term Capsule Tests Accomplishments

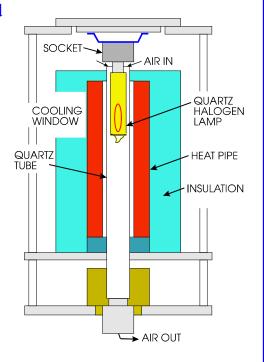
•Developed highly effective cleaning method

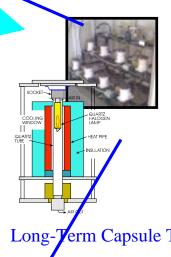
•Critical to long life in sodium

- •Developed low-cost cleaning method
  - •Demonstrated nearly as effective
  - •Suitable long life
- •Tested alternate materials combinations for sodium compatibility
  - •Plating to improve bonding
  - Perf metal overlay
- •Over 30000 hours accumulated

on some capsules



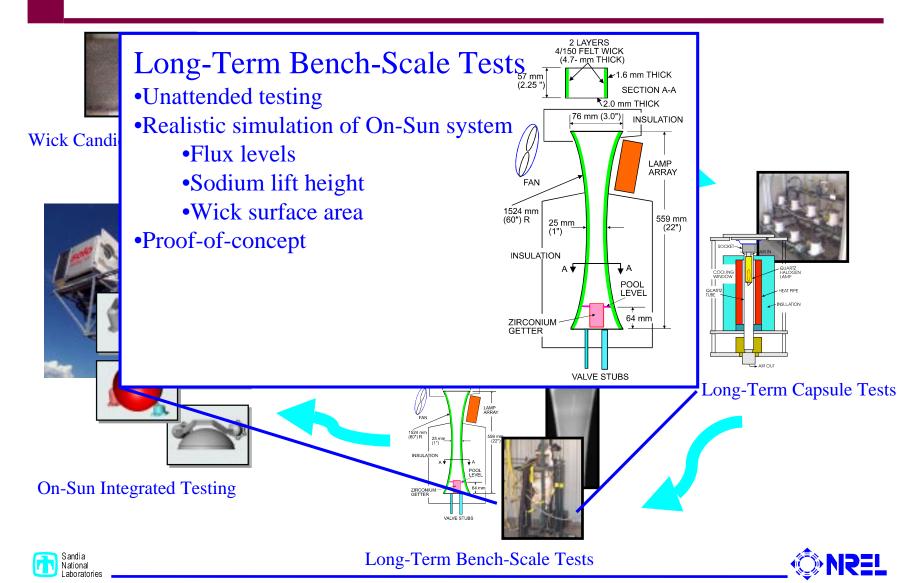


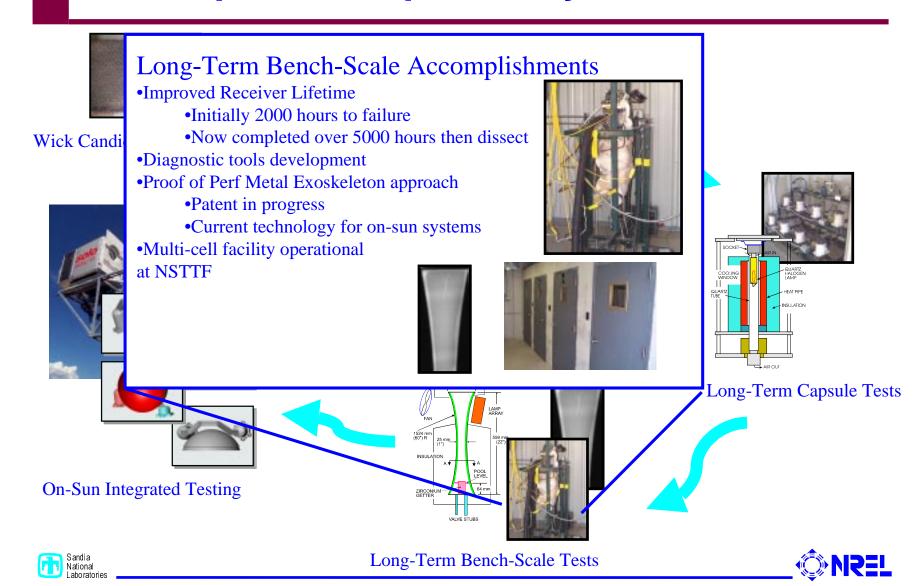


Long-Term Capsule Tests

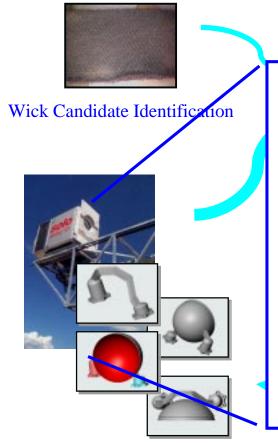










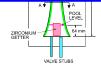




#### **On-Sun Integrated Testing**

- •Real-world proof of wick concepts
  - •Flux
  - Power throughput
  - Transients
  - Vibrations
- •Integrated with engine or calorimeter testing
- •Engine interface development
- Apply World-class facilities at NSTTF

ests



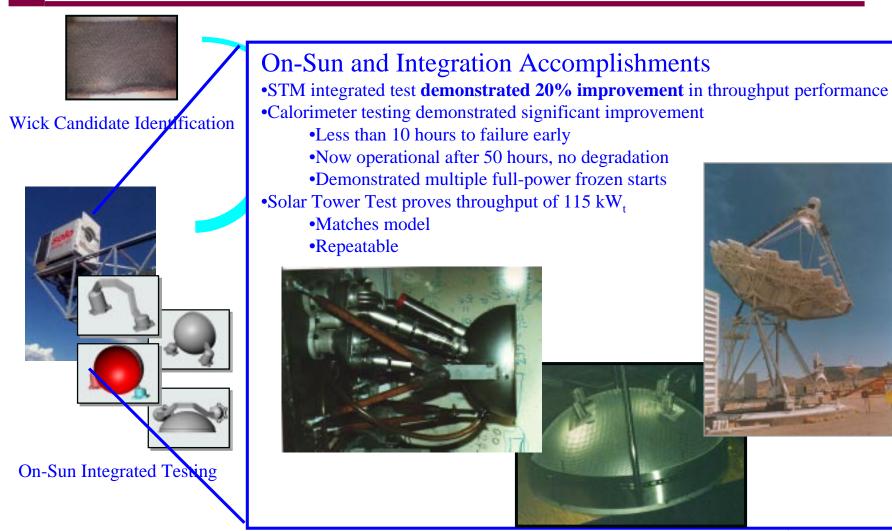






Long-Term Bench-Scale Tests

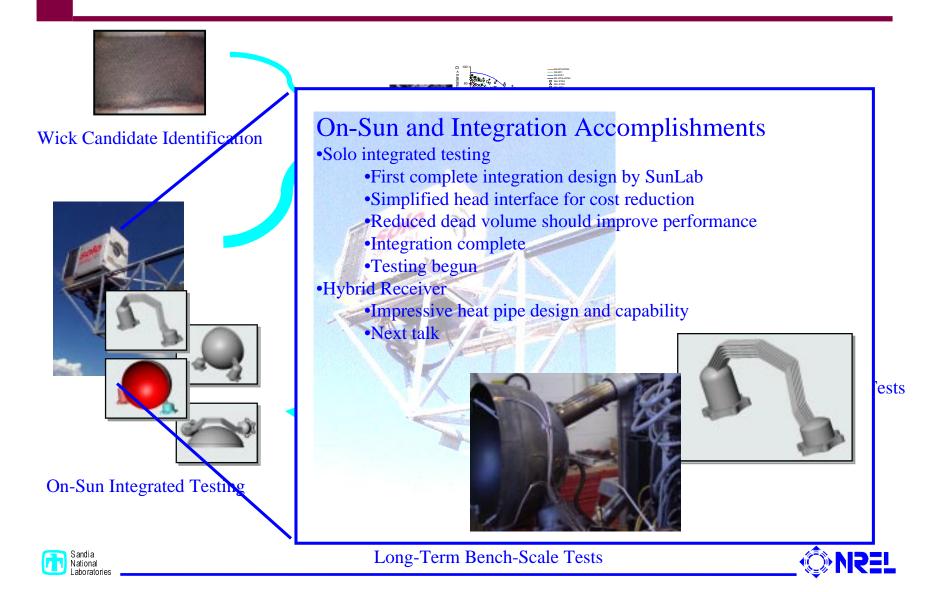


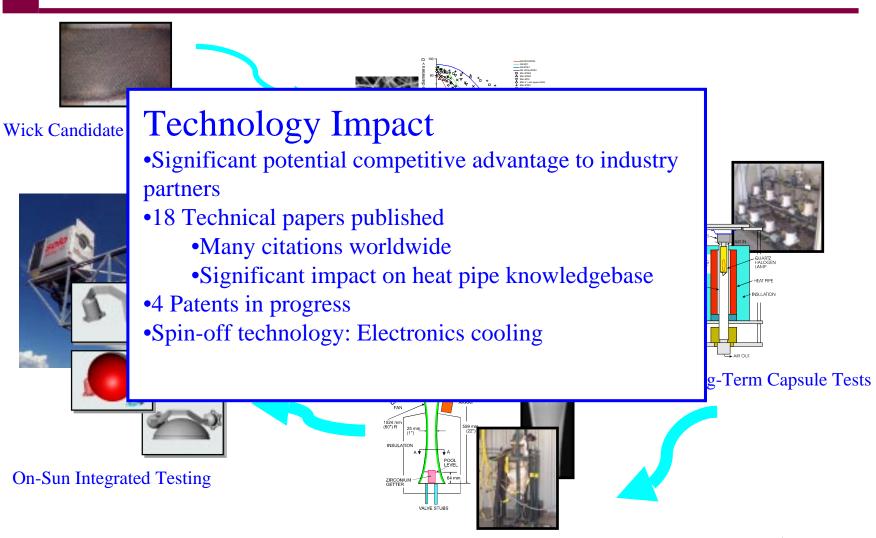








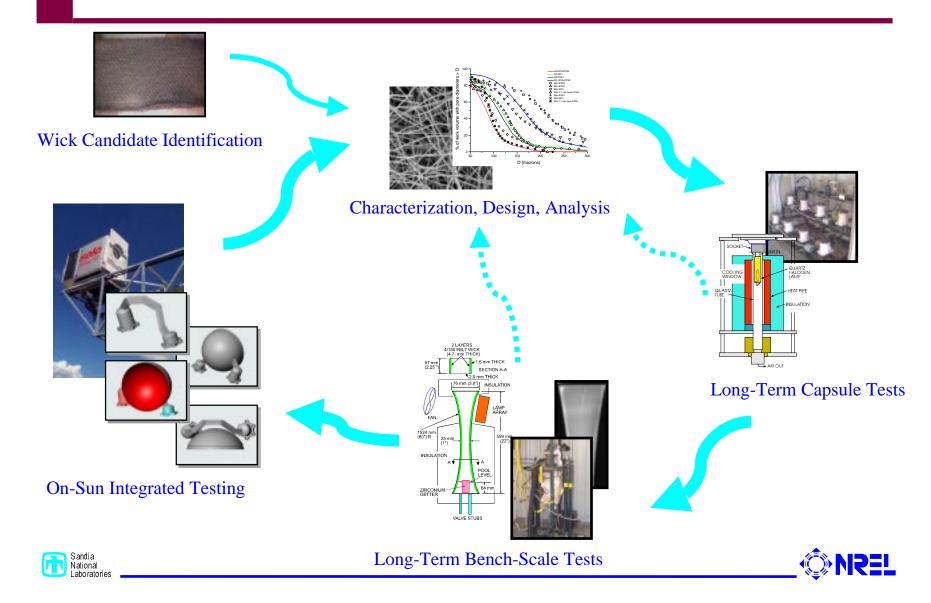


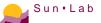






#### Sun•Lab





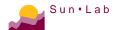
### **Development Areas**

- Engine interface
  - Long-term testing on Solo
  - Controls issues
  - Multi-cylinder application
  - Integration Issue
- Wick Development
  - Wick compression controlled, not solved
    - Life issue
  - Occasional hot spot
    - Reliability Issue







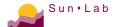


#### **Summary**

- We have demonstrated significant performance benefits for heat pipe receivers
- We have developed and demonstrated effective cleaning methods for felt wicks
- We have improved wick life substantially, from hours to over 5000 hours
- We have and continue to integrate heat pipe receivers with engines and dish systems
- We have expanded the limits of traditional heat pipe technology, doubling state-of-the-art performance
- We have continued to keep Industry Partners informed
- We have identified key development areas







#### SunLab Heat Pipe Development Assets

#### People

- World-class experts on high temperature heat pipes
- Dedicated staff working and producing at high levels
- Additional matrixed staff (metallurgy, NDT, etc.)

#### Facilities

- Round-the-clock testing on capsules and bench-scale heat pipes
- Sodium filling and handling rivaled nowhere
- Instrumentation and analysis tools
- NSTTF

#### Technology

- Sandia wick technology out-performs industry and lab standards by factor of two
- Practical tools and application unmatched

#### Partners

- IPP program with former soviet labs significantly leverages our money (\$358k, half to labs)
- Industry partners developed to manufacture proposed wicks



